FOREST PEST MANAGEMENT

TREE DISEASE SURVEY OF CONIFERS IN THE BLACK HILLS - 1990

by

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Technical Report R2-51

September 1991

Renewable Resources
Rocky Mountain Region
USDA Forest Service
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ACKNOWLEDGEMENTS

This paper was reviewed by Pete Angwin, Rich Dorset, Frank Hawksworth, Bill Jacobi, Dave Johnson, and Judith Pasek. Their help is gratefully acknowledged.

ABSTRACT

This paper presents an overview of the state of knowledge of the most commonly documented conifer tree diseases in the Black Hills. These include Armillaria root disease of pine, wood decays of pine, pine stem rusts, Chrysomyxa rusts of spruce, Gymnosporangium rusts of juniper, Elytroderma needle cast of pine, and Sphaeropsis dieback of pine. Compared to forests elsewhere, relatively few studies have been done on tree diseases in the Black Hills. Distribution maps are presented based on information gathered from herbarium records, published and unpublished papers, and data collected during a disease survey in summer 1990.

INTRODUCTION

Boldt et al. (1983) described tree diseases in the Black Hills as "chronically troublesome." Actually, little is known of their occurrence and distribution. Even less is known about their impact. After a search for information about diseases in the Black Hills, lists of fungi previously reported on trees in this region were compiled (Lundquist 1991b, 1991c). These lists showed that the most commonly documented diseases in the region have been Armillaria root disease of pine, wood decays of pine, pine stem rusts, Chrysomyxa rusts of spruce, Gymnosporangium rusts of juniper, Elytroderma needle cast of pine, and Sphaeropsis dieback of pine. During a recent survey for Armillaria root disease (Lundquist 1991a), several incidental sitings of other diseases were made. This paper documents those sitings and reviews the present state of our knowledge of diseases other than Armillaria root disease in the Black Hills. Survey results for Armillaria root disease are published elsewhere (Lundquist 1991).

WOOD DECAYS OF PINE

Red rot of ponderosa pine, caused by Dichomitus squalens (P. Karst.) D. Reid, was the first tree disease to be studied intensively in the Black Hills. Von Schrenck (1903) found that it was a major cause of deterioration in beetle killed timber, and that the causal agent was also able to cause decay in living trees. Red rot was later shown to be the most significant source of defect in mature Pinus ponderosa stands, where it destroyed as much as 22% of the gross scale (Eldredge 1928, Pearson and Marsh 1935, Lightle and Andrews 1968). Andrews and Gill (1941) found in immature stands (up to 140 years old) that disease incidence increased rapidly in trees older than 80 years. Hinds (1968, 1971) found that decay losses in merchantable-sized trees amounted to 15.9% of gross volume and were caused not only by red rot (8.6%), but by brown rots (7.3%) as well. From brown rotted wood, Hinds isolated several fungi of which Veluticeps berkeleyi was the most common. Previously, Phaeolus schweinitzii was thought to be the most prominent brown rot fungus. V. berkeleyi was described in detail in a separate study (Gilbertson et al. 1968). Several other decays of living ponderosa pine have been noted in the Black Hills (Table 1), but nothing about their distribution and impact has been investigated.

PINE STEM RUSTS

Three pine stem rusts occur in the Black Hills (Table 1). These are comandra blister rust caused by Cronartium comandrae, limb rust caused by Cronartium arizonicum and western gall rust caused by Peridermium harknessii. The first two rusts are hetereocious, requiring two separate hosts to complete their life cycle. Western gall rust is autoecious. The aecial host for all three of the rusts is pine. The telial hosts are common comandra (Comandra umbellata (L.) Nutt.) for comandra rust and paintbrush (Castilleja sp.) for limb rust.

TABLE 1. Diseases that have been reported on pine, spruce and juniper in the Black Hills (compiled from Lundquist 1991b, c).

DISEASE COMMON NAME	PATHOGEN
Pine (*Pinus ponderosa* Douglas ex P. Laws.)	
Armillaria root disease	*Armillaria* sp.
Limb rust	*Cronartium arizonicum* Cummins
Comandra blister rust	*Cronartium comandrae* Peck
Elytroderma disease	*Elytroderma deformans* (Weir) Darker
Western gall rust	*Peridermium harknessii* J.P. Moore
Lophodermella needle cast	*Lophodermella cerina* (Darker) Darker
Blue stain	*Ophiostoma ips* (Rumbold) Nannf.
	Ophiostoma minus (Hedgc.) Syd. & P. Syd.
Sphaeropsis dieback	*Sphaeropsis sapinea* (Fr.: Fr.) Dyko & Sutton
Wood rot in living trees	*Coniophora puteana* (Schum.: Fr.) Karst.
	Dichomitus squalens (P. Karst.) D. Reid
	Fomitopsis pinicola (Sw.: Fr.) P. Karst.
	Ganoderma applanatum (Pers.) Pat.
	Inonotus tomentosus (Fr.: Fr.) S. Teng
	Laetiporus sulphureus (Bull.: Fr.) Murrill
	Phaeolus schweinitzii (Fr.: Fr.) Pat.
	Phellinus pini (Thore.: Fr.) A. Ames
	Veluticeps berkeleyi (Berk.: Curt.) Cke.
Spruce (*Picea glauca* (Moench) Voss)	
Armillaria root disease	*Armillaria* sp.
Spruce broom rust	*Chrysomyxa arctostaphyli* Dietel
Cone rust	*Chrysomyxa pirolata* G. Wint.
Spruce needle rust	*Chrysomyxa weirii* Jacks
Cytospora canker	*Cytospora kunzei* Sacc.
Wood rot of living trees	*Coniophora puteana* (Schumach.:Fr.) P. Karst
	Fomitopsis officinalis (Vill.:Fr.) Bondartsev & Singer
	Phaeolus schweinitzii (Fr.:Fr.) Pat.
Juniper (*Juniperus* L. spp.)	
Juniper broom rust	*Gymnosporangium nidus-avis* Thaxt.
Clavariform-juniper rust	*Gymnosporangium clavariiforme* (Wulfen in Jacq. ex Pers.) DC
Quince rust	*Gymnosporangium clavipes* (Cooke & Peck) Cooke & Peck in Peck
Cedar-apple rust	*Gymnosporangium juniperi-virginianae* Schwein.
Lophodermium needlecast	*Lophodermium juniperinum* (Fr.) De Not.

Comandra Rust

Luckinbill (1935) was the first to report comandra blister rust in the Black Hills, although Brenckle (1918) had previously found it on Geocaulon lividum (Richardson) Fernald north of here at Camp Crook, S.D. Luckinbill noted that rust was very common and severe in young stands of P. ponderosa. For some reason, however, this disease became much less severe in subsequent years. Nothing more about its distribution was documented until Peterson's rust surveys of 1960, when it was found near Moskee, Roubaix, and Deerfield. In a footnote, Peterson (1962) notes that he found only old cankers and no new infections. This disease has since gone unstudied.

Limb Rust

Limb rust on ponderosa pine was found by S.R. Andrews in 1936 near Roubaix (Peterson 1959). Details about this report are undocumented. Thurston and Kern (1930) recorded "Cronartium harknessii" on Castilleja sulphurea Rydb. near Sylvan Lake, but this probably was a misidentification for C. arizonicum (R.S. Peterson, pers. com.). Apparently, further studies were done only in 1959, when Peterson collected specimens from the telial hosts Castilleja sessiliflora Pursh, Castilleja sulphurea, and Orthocarpus luteus Nutt. near Custer, Deerfield, Rochford, Este, Lead, and Moskee. Peterson (1959) notes that the rust was "not damaging" to pine. Further information about its distribution is lacking. In the present survey, the distribution of townships where trees were found showing symptoms of limb rust is shown in Figure 1.

Western Gall Rust

Peterson (1959) first published that P. harknessii was in the Black Hills, although it had been found earlier (1935) by S.R. Andrews and L.S. Gill (Lundquist 1991c). This latter report was never published. Peterson's paper describes severely infected trees near Windy Flats (T4NR4E), where disease incidence was as high as 47%. Nearly all of the infected trees had bole galls that would eventually destroy their merchantability. Peterson also reports this rust in one of the few Pinus contorta Douglas & Loud. stands in this region and on Pinus sylvestris L. In a later survey, Johnson, James and Gillman (G.L. Downing, October 4, 1978, unpublished report) found western gall rust widespread and locally intense in some places. R. Dorset (South Dakota Division of Forestry) has subsequently reported many other sightings of this disease (Lundquist 1991c). In the present survey, western gall rust was found in the locations (townships) shown in Figure 2.

CHRYSOMYXA RUSTS OF SPRUCE

Three Chrysomyxa rust diseases of spruce have been recorded in the Black Hills. These are broom rust caused by Chrysomyxa arctostaphyli, cone rust caused by Chrysomyxa pirolata, and needle rust caused by Chrysomyxa weirii. The first two rusts are hetereocious. C. weirii is auteocious. The aecial host for all these rusts is spruce. The telial hosts are kinnikinnick (Arctostaphylos uva-ursi (L.) Spreng.) for broom rust (no urediospores are produced) and snowline Pyrola (Pyrola minor L.) for cone rust.

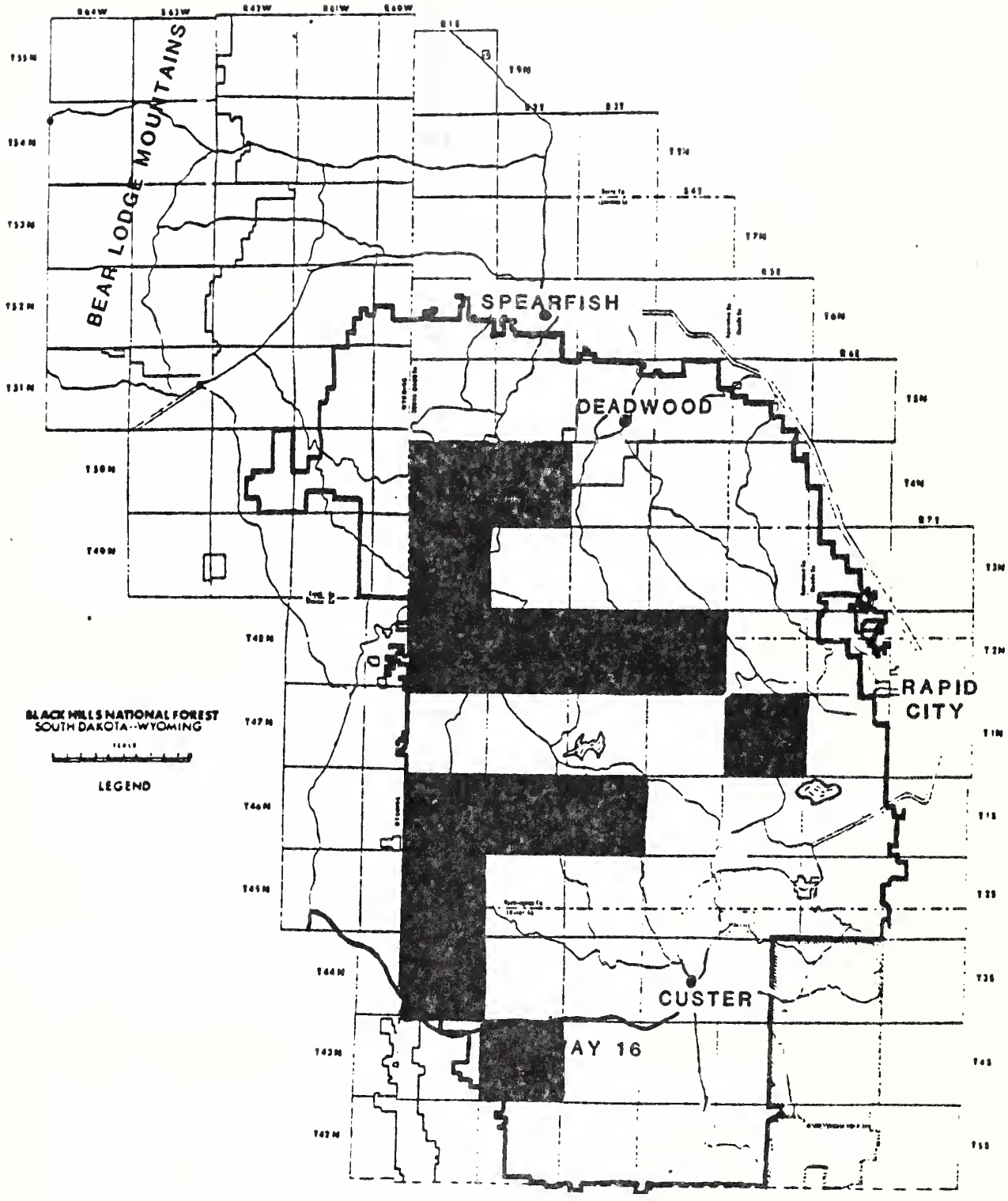

Figure 1. Distribution of townships with trees showing symptoms of limb rust during a tree disease survey of the Black Hills in summer 1990.

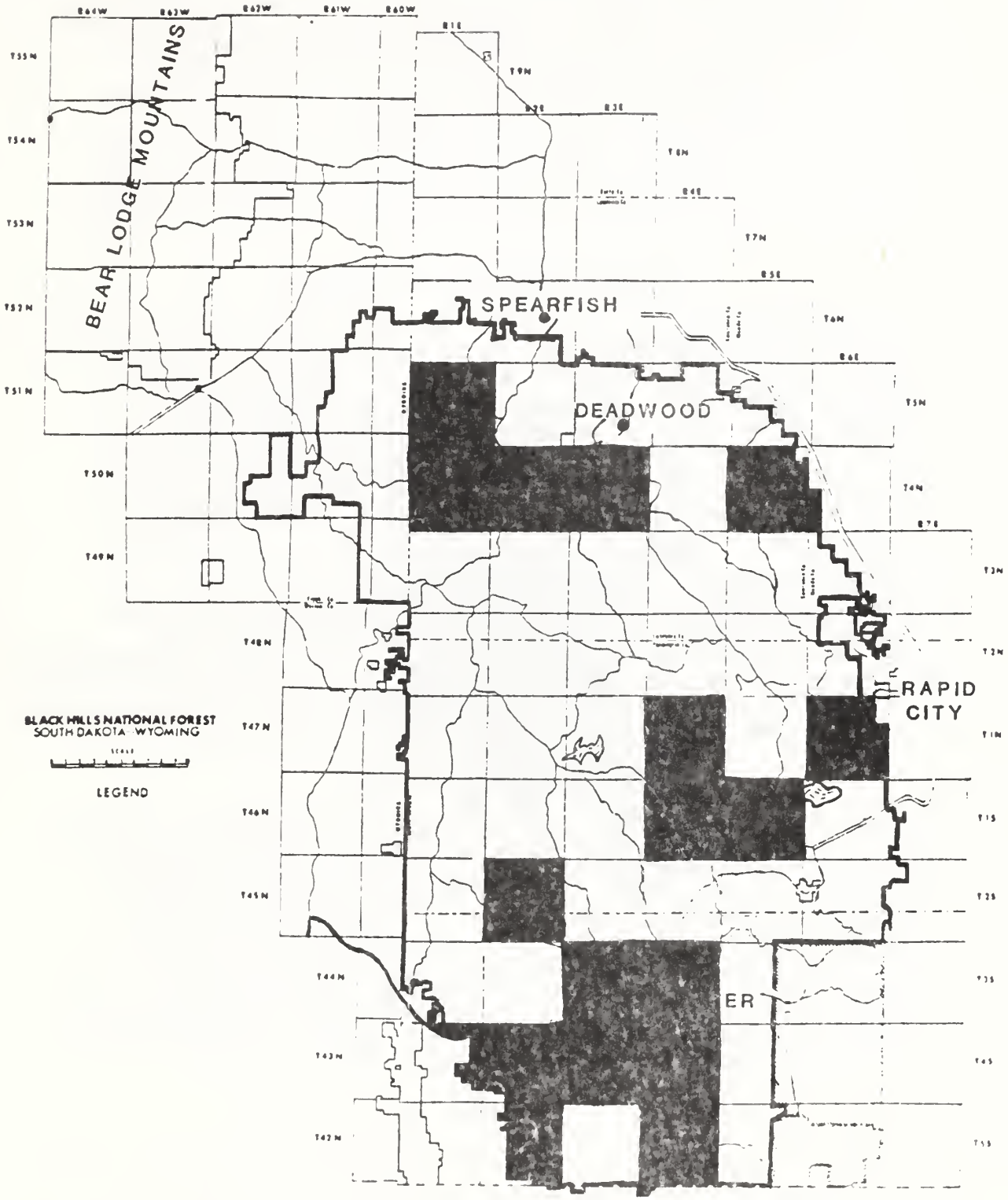

Figure 2. Distribution of townships with trees with western gall rust found during a tree disease survey of the Black Hills in summer 1990.

Peterson's (1961) report of C. weirii on white spruce (Picea glauca) was the first report for this host in the U.S. He describes the pathogen as abundant on trees in many places, "...with nearly all of the previous year's needles infected on the lower branches." Peterson also records the occurrence of Chrysomyxa pirolata on P. minor, which was a first report for the Black Hills. He describes this rust as common on P. minor, but could find none of it on spruce cones. Furthermore, Peterson reports C. arctostaphyli on A. uva-ursi near Rochford; a first report of the telial stage in the Black Hills. He states that infection of the aecial host (white spruce) was common. His paper may, in fact, be the first published report of this rust on spruce in the Black Hills. In the present survey, trees with symptoms of spruce broom rust were found at the locations (townships) shown in Figure 3.

GYMNOSPORANGIUM RUSTS OF JUNIPER

Several Gymnosporangium rust diseases have been reported in the Black Hills. Most of these reports were made by R.S. Peterson during a survey in July 1960. Peterson found Gymnosporangium clavariforme on Juniperus communis L., Gymnosporangium clavipes on Amelanchier alnifolia Nutt, Gymnosporangium nelsonii on A. alnifolia (Peterson 1962) and Gymnosporangium nidus-avis on Juniperus scopulorum Sarg. (Peterson 1962). Gymnosporangium juniperi-virginianae Schwein. has also been reported (Lundquist 1991b). All these Gymnosporangium species are hetereocious, using Juniperus spp. as the telial host. Aecial hosts vary.

Juniper broom rust is a stem disease of Rocky Mountain Juniper (J. scopulorum) caused by G. nidus-avis. Infected trees develop stem swellings and witches' brooms. Specimens of this disease were collected by R.S. Peterson in 1960 from Hells Canyon near Jewell Cave. No earlier reports were found. The telial host is serviceberry (Amelanchier sp). During the present survey, junipers with symptoms of broom rust were found in locations (townships) shown in Figure 4.

ELYTRODERMA NEEDLE CAST

Elytroderma needle cast is a needle disease of ponderosa pine caused by Elytroderma deformans. Apparently, its past activity in the Black Hills has not been documented. In the present survey, E. deformans was found to be widespread. Disease intensity varied among locations. However, only scattered trees were affected and overall disease incidence was low. Infected trees had needle cast, witches' broom, or both. Because these symptoms are also caused by dwarf mistletoe, Elytroderma needle cast has been the basis for several reports of dwarf mistletoe in the Black Hills; e.g. Tidestrom 1925 (F. Hawksworth pers. com.). Trees showing symptoms of Elytroderma needle cast were found at locations (townships) shown in Figure 5.

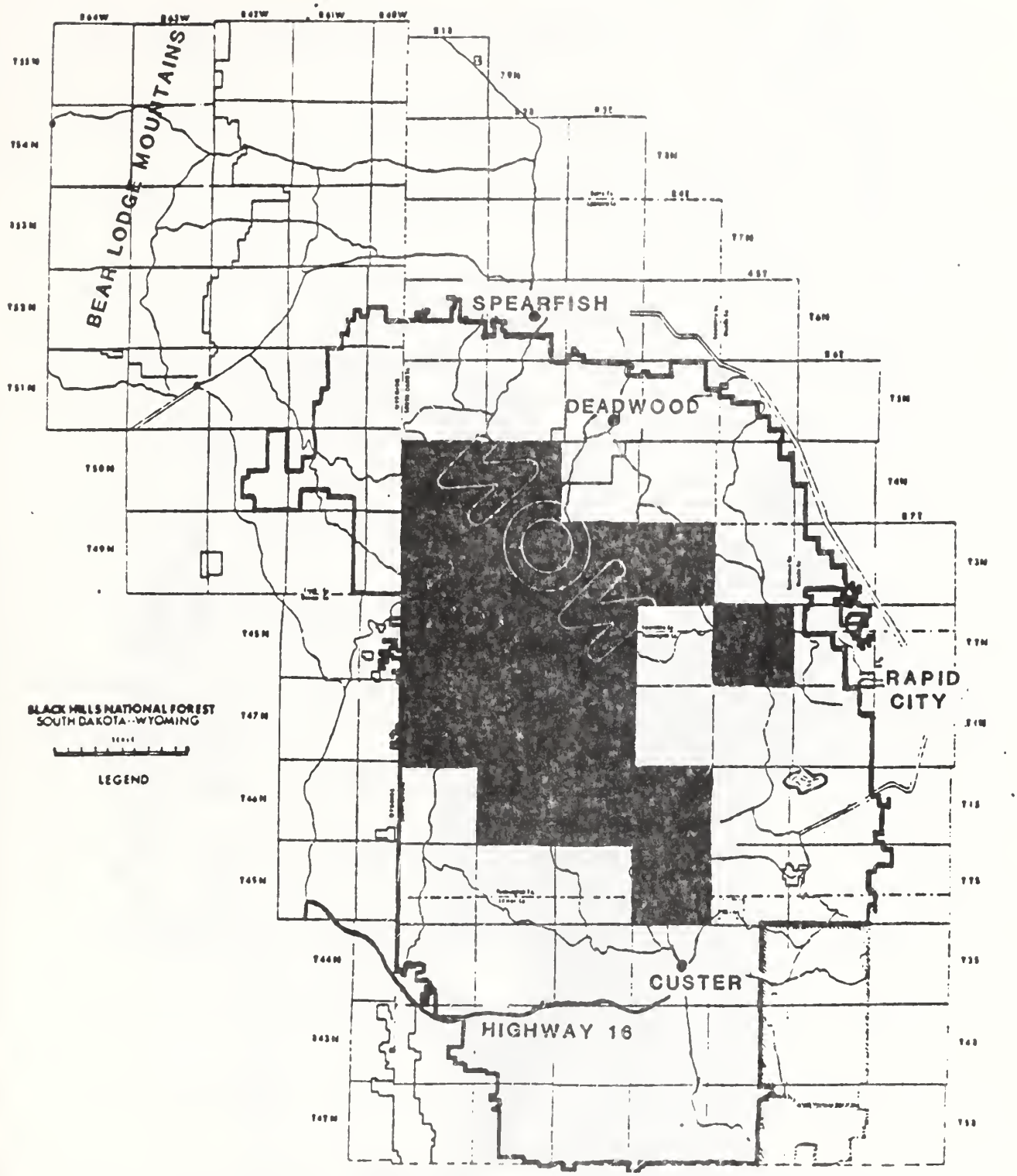

Figure 3. Distribution of townships with trees showing symptoms of spruce broom rust during a tree disease survey of the Black Hills in summer 1990.

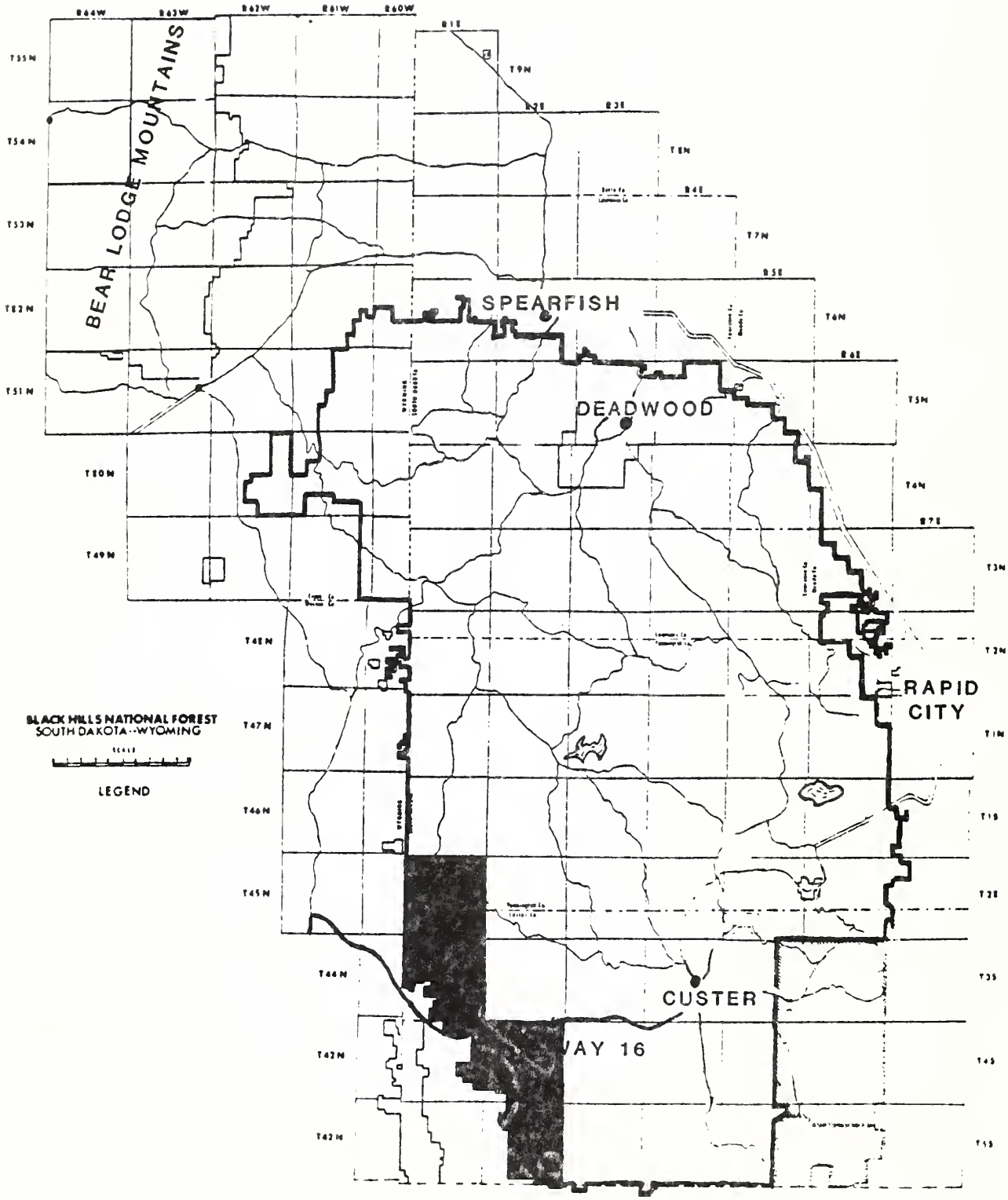

Figure 4. Distribution of townships with trees showing symptoms of juniper broom rust during a tree disease survey of the Black Hills in summer 1990.

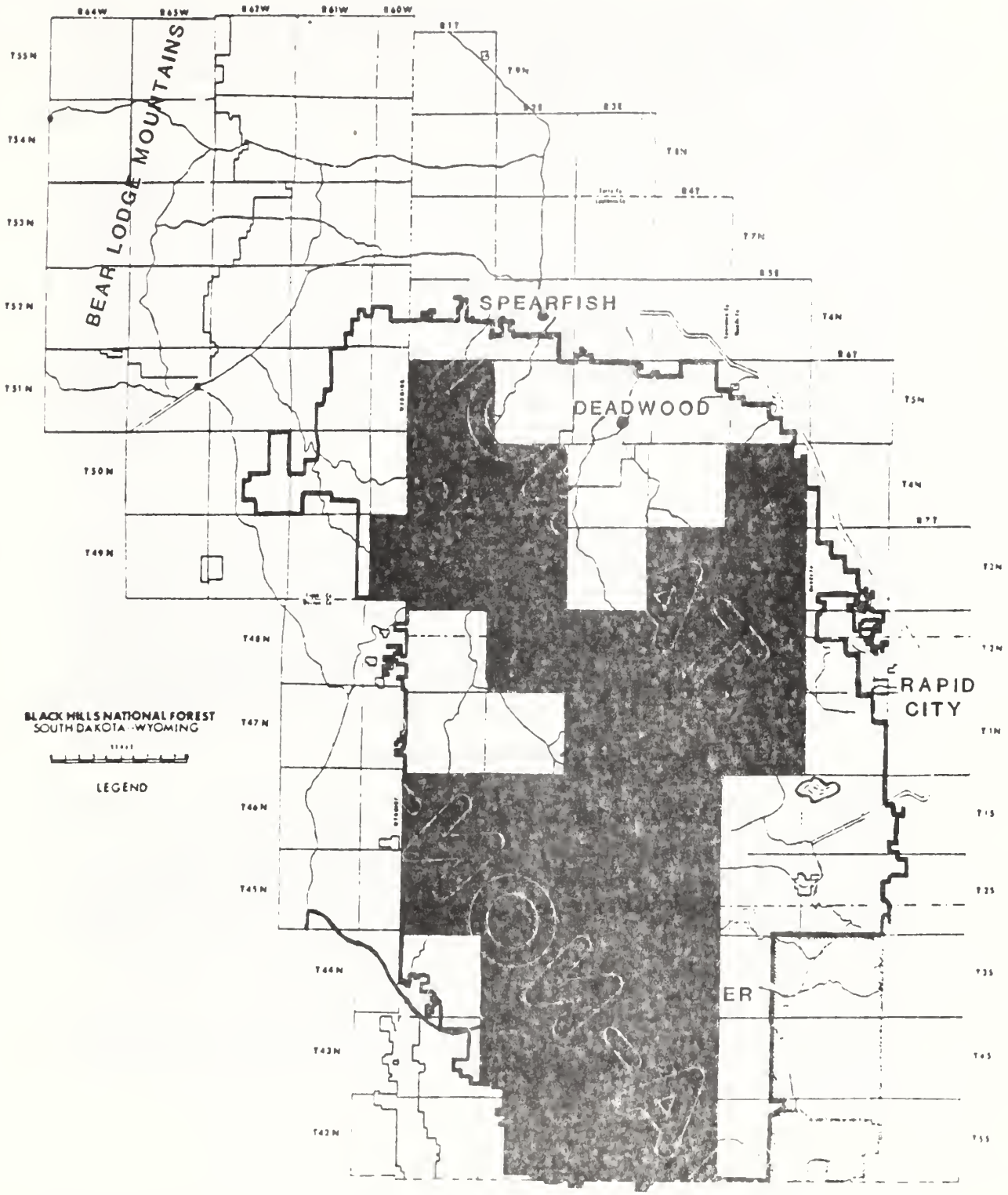

Figure 5. Distribution of townships with trees showing symptoms of Elytroderma disease during a tree disease survey of the Black Hills in summer 1990.

SPHAEROPSIS DIEBACK

Sphaeropsis dieback, caused by Sphaeropsis sapinea, was first reported in the Black Hills in 1979 (James et al. 1979). This was also the first time the disease was reported on mature, native P. ponderosa. Infected trees were most common in openings and stand edges and most noticeable on branches with many cones. Diseased trees were found as far south as Wind Cave National Park, but were most common on the Nemo Road, 5 miles west of Rapid City. From 1979 to 1983, Sphaeropsis dieback was surveyed and monitored closely for spread. As a result, probably more is known of its distribution than other tree disease in the area. Because diseased trees were found scattered over a large area, it was suggested that S. sapinea was a pathogen native to the Black Hills and had become prominent because of a combination of favorable weather conditions and a large cone crop (Johnson et al. 1981; Johnson et al. 1983). Black Hills isolates were cultured on artificial media and compared with other isolates from across the globe, but no differences were found (Johnson et al. 1985). In the present survey, Sphaeropsis dieback was found mostly in the same places as in previous studies, but intensity was low. Trees with symptoms of Sphaeropsis dieback were found at the locations (townships) marked in Figure 6.

SPRUCE DYING

Spruce (Picea glauca) mortality is caused by an as yet undefined agent. The symptom syndrome of this disorder has yet to be described, but in the final stages of decline scattered individuals or groups of trees die. More work is required to determine the cause. In this survey, most stands with this disorder were found in the west central area of the Black Hills; a distribution that coincides with the host. Trees with symptoms of this disorder were found at the locations shown in Figure 7.

OTHER TREE DISEASES

Several diseases other than those described above have been reported on conifers in the Black Hills. Blue stain in ponderosa pine wood was one of the first diseases studied. Other than a few collections, no further work was done on it since von Schrenck did his studies in 1903. Several saprophytic wood decay fungi from pine were collected by Seaver and Shope during a mycological foray near Sylvan Lake and Wind Cave (Thurston and Kern 1931, Overholz 1933, Seaver and Shope 1935, Seaver and Shope 1936). Many more were found by Hinds (1968 1971; Table 2). Armillaria root disease, Cytospora canker and Lophodermium needle cast have been reported for spruce. This report is limited to diseases of pine, spruce and juniper. Several reports of diseases on aspen, birch, oak, chokecherry and ash and other tree species are also documented (Lundquist 1991b).

Table 2. Wood rot fungi that have been reported from dead pine, spruce, and juniper trees in the Black Hills (compiled from Lundquist 1991b, c).

Pine

Androdia alpina (Litsch.) R.L. Gilbertson & Ryvarden
Androdia sinuosa (Fr.: Fr.) P. Karst.
Androdia variiformis (Peck) Donk
Calocera cornea (Batsch:Fr.) Fr.
Dacrymyces capitatus Schwein.
Dacrymyces stillatus Nees:Fr.
Diplomitoporus linbladii (Berk.) R.L. Gilbertson & Ryvarden
Gloeophyllum odoratum (Wulf.: Fr.) Imazeki
Gloeophyllum sepiarium (Wulf.: Fr.) P. Karst.
Gloeoporus dichrous (Fr.: Fr.) Bres.
Grandinia granulosa (Pers.: Fr.) Fr.
Junghuhnia collabens (Fr.) Ryvarden
Merulius sp.
Peniophora rufa (Fr.: Fr.) Boidin
Peniophora sp.
Phanerochaete gigantea (Fr.: Fr.) S.S. Rattan et al. in S.S. Rattan
Phellinus igniarius (L.: Fr.) Quel.
Phellinus viticola (Schwein.: Fr.) Donk
Phlebiella vaga (Fr.: Fr.) P. Karst.
Poria sp.
Pycnoporus sanguineus (L.: Fr.) Murrill
Serpula himantioides (Fr.: Fr.) P. Karst.
Stereum hirsutum (Wild: Fr.) S.F. Gray
Trichaptum abietinum (Dickson: Fr.) Ryv.
Vararia boreale Pouzar

Spruce

Botryobasidium vagum (Berk. & M.A. Curtis) D.P. Rogers ex Linder
Gloeophyllum sepiarium (Wulfen:Fr.) P. Karst.
Junghuhnia collabens (Fr.) Ryvarden
Tomentella sp.

Juniper

Grandinia granulosa (Pers.:Fr.) Fr.

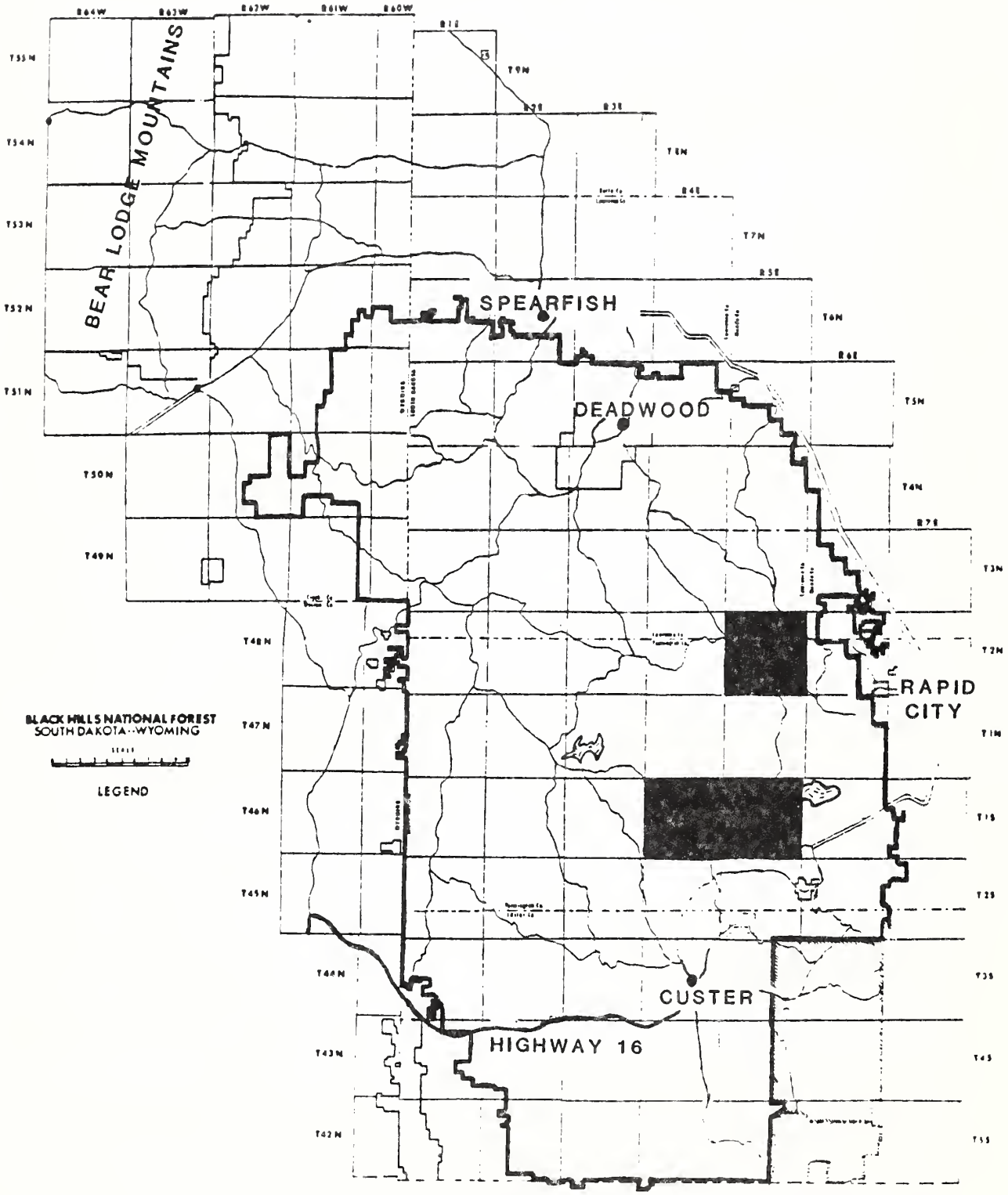

Figure 6. Distribution of townships with trees showing symptoms of Sphaeropsis dieback during a tree disease survey of the Black Hills in summer 1990.

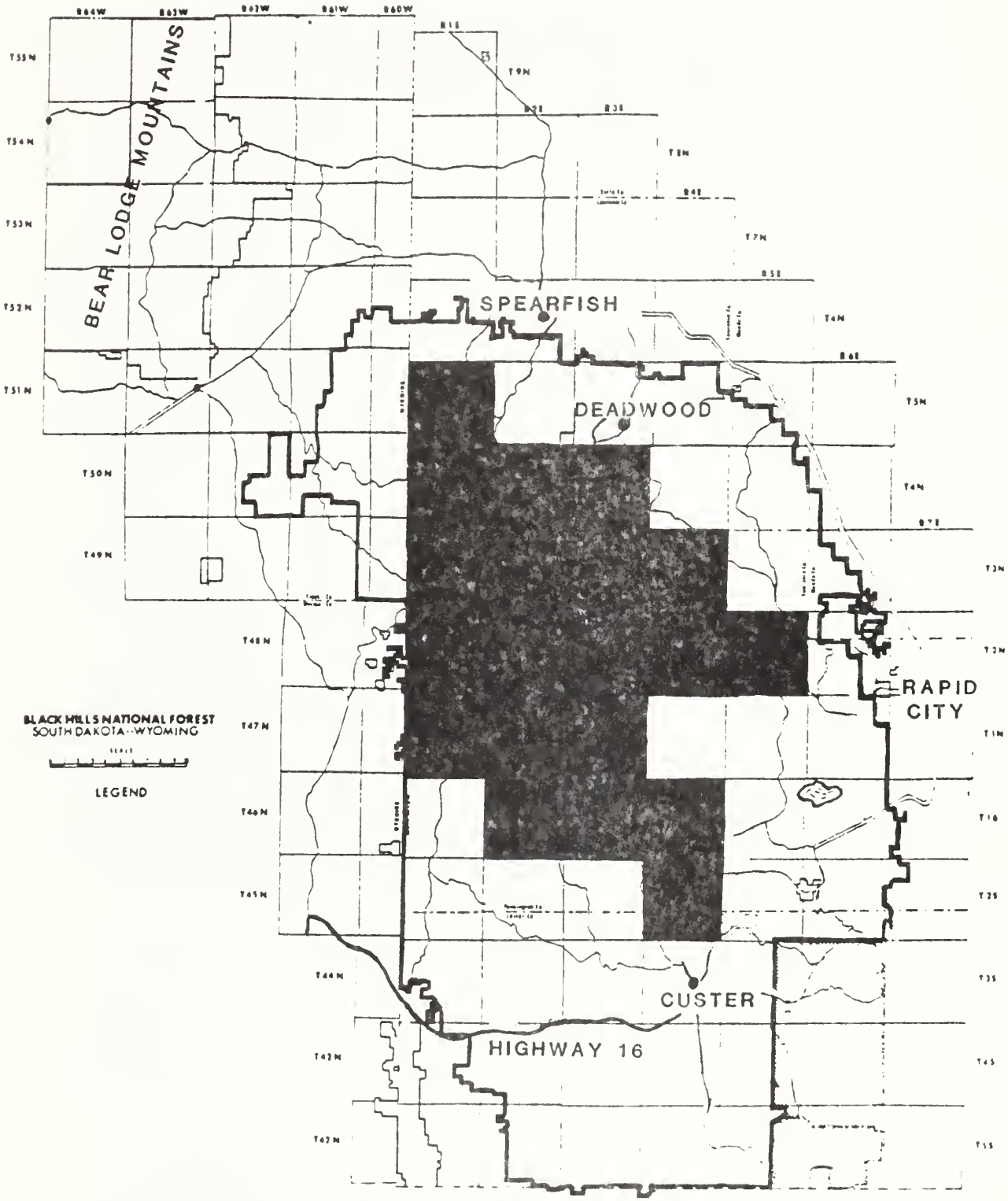

Figure 7. Distribution of townships with trees showing symptoms of spruce dying during a tree disease survey of the Black Hills in summer 1990.

DISCUSSION

Most major diseases of ponderosa pine, spruce, and juniper that occur elsewhere in the Rocky Mountain Region (Johnson 1985), occur in the Black Hills as well (Table 1). Compared to other forests, however, relatively few pathology studies have been conducted in the Black Hills. Consequently, almost nothing is known about tree disease distribution, impact, and potential for becoming more intense. However, some speculation can be made based on the data presented above. For instance, some of the diseases listed in Table 1 have the potential to suddenly increase and decrease in intensity. Lophodermella needle cast, for example, became intense in ponderosa pine stands between Custer and Deadwood around 1981, but relatively few reports of it have been documented since. Similarly, Sphaeropsis dieback was prevalent from 1979 to 1983, but is currently much less noticeable. Many other foliage diseases and some stem diseases show the same patterns. These sudden fluctuations in disease incidence are thought to be related to climatic conditions at certain stages in the pathogen's life cycle. The occurrence of these diseases is difficult to predict and the distribution may change from year to year. In the Black Hills, we can expect periodic outbreaks of Elytroderma needle cast, Lophodermella needle cast, Sphaeropsis dieback of pine, and needle and cone rusts of spruce. Most of these diseases cause growth losses or growth deformations, but seldom cause tree mortality.

Pine stem rusts, on the other hand, have the potential to cause serious stem deformations and tree mortality. Describing what must have been an epidemic of comandra rust several years ago, Luckinbill (1935) noted that diseased stands were "very frequent" in young ponderosa pine, and that between 10 and 15% of the trees in infected stands were diseased. Luckinbill also noted that diseased trees usually died before they grew larger than 14 inches dbh. Since rusts need living hosts to survive, comandra blister rust may be self-limiting. The incidence of this disease now appears to be much less than that described in the 1930s. Limb rust is apparently maintaining a foothold in the Black Hills better than comandra blister rust, but its low incidence indicates that future epidemics are unlikely. Western gall rust may be different. The inoculum load is high enough that new stands are continually being infected. Like the foliage diseases, its intensity will depend on the weather at certain times of its life cycle. It appears that of the three pine stem rusts, western gall rust poses the greatest threat to forests in the Black Hills.

Most wood decays of living trees are more prevalent as trees age. Since the rotation age of stands in the Black Hills is much less than it once was, wood decays will probably cause fewer problems in future forests managed on shorter rotation ages. Some decays and many stem cankers, however, can cause mortality of younger trees. Often the distribution of these diseases is determined by other stresses. Consequently, Armillaria root disease and Cytospora canker may become more intense in drought years, or as a consequence of wounds caused by logging or fire.

This paper presents an overview of the state of knowledge of conifer tree diseases in the Black Hills. It is based on a compilation of scattered information, which was gathered from herbarium records, published and unpublished papers, and data collected during a disease survey in summer 1990. The thoroughness of this survey is difficult to gauge. Undoubtedly, more information exists. Hopefully, a more complete listing will emerge in the future as additional studies and literature searches are conducted.

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